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APPLIED SATELLITE TECHNOLOGY WILL BECOME AN IMPORTANT
INDUSTRY AMONG HIGH SCIENTIFIC AND TECHNOLOGICAL FIELDS

Hou Wenzhong

ABSTRACT This article outlines the necessity and importance of China's developing applied satellite technology. It delineates the composition and classifications associated with applied satellite systems. Emphasis is placed on analyzing the economic benefits, social benefits, as well as functions with regard to various trades and respective enterprises associated with various types of applied satellite systems.

KEY WORDS Applied satellite + Satellite application+
Social benefit+ Economic results+

In the 1950's, the sending aloft of the Soviet Union's first man made satellite gave rise to huge reverberations in the world.

However, speaking only in terms of the economic benefits, at that time, they could be said to be, by contrast, "high negative values" or almost nonproductive. However, today--after the more than 30 years since--following along with satellite and satellite application technologies, rapid and intense development from military uses to various realms of civilian use has already caused the problems associated with bad economic benefits to no longer exist. It should be said that satellite and satellite application technologies are already--or are on the verge of--giving rise to the attention of the people of the world and causing the various nations of the world to produce huge economic benefits and social benefits associated with a burgeoning high scientific and technological industry in economics, trade, politics, military affairs, culture, as well as the lives of the people. As far as its development and applications are concerned, it will produce inestimably important influences with regard to the development of the national economy's various trades and enterprises.

The United Nations' space commission has clearly announced to the various nations of the world: "Making use of space technology is a short cut in the developing of nations to approach the levels of advanced countries and the development of economies. The reason is that it is capable of leaping over the traditional technology development stage which advanced nations have already gone through." This is nothing else than to say that, following along with a vigorous interest in space technology, there will, in conjunction with this, be a tendency toward familiar maturity. In terms of technology, the advanced nations of the West confront a new stage in renovation and generational replacement. Moreover, the moment in time associated with this renovation and generational replacement is just right as an important opportunity to shrink the distance in technological terms between developing countries and the advanced nations. As a result, there has been formed in the world a new current of fervor in the industries of various nations competing with each other to develop satellite applications. At the present time, on a world scale, there are already over 170 nations and regions that have joined these ranks. Among them, nations with economic development levels similar to China's--Indonesia, India, Brazil, Argentina, and so on--already go ahead of China in terms of the depth and breadth of national applications in development. Of course, in terms of test manufacture and production capability, we still are in the world's front rank.

In accordance with the point of view of the United Nations'

space commission, the 1990's will be a trend toward familiarization and maturity of satellite application technologies. In conjunction with this, it will be an entry into a golden development phase. Moreover, with regard to China, the 1990's will also be an important era associated with a need to broaden even more markets associated with satellite application industries and great strides in the development of satellite application industries.

At the present time, in astronavigational technology, applications of satellites, carrier rockets, as well as satellite application systems have already or are just in the process of entering into the commercial market and will form a new and developing industry with great prospects. What needs to be explained is that the basic reason why satellite application systems are capable of entering into commercial product markets in a big way lies--compared with the same type of traditional technological products and besides the introduction and production of relatively good quality and comparatively high performance-price ratios and also, for instance, not being subject to limitations of the geographical environment, that is, oceans, deserts, high mountains, and so on--in being able to get through in the acquiring and transmitting of information in an unobstructed way. This is an advantage which other traditional technologies have no way to possess.

I. SATELLITE APPLICATION SYSTEMS

Various types of satellite economic benefits, social benefits, as well as military values all require going through huge surface satellite application systems. Only then is it possible to realize them. Otherwise, satellites hanging unseen and untouchable in space have no value for the human race whatever. Moreover, satellites that do not have surface satellite application systems, also have no significance. Strictly speaking, satellite applications are composed of two parts, that is, useful load on satellites and surface satellite application systems.

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Due to different uses associated with satellites, as a result, satellites with different uses have different satellite application systems--for example, satellite television application systems, satellite communications application systems, satellite navigation and positioning application systems, satellite metrology application systems, oceanic satellite application systems, satellite resource application systems, as well as military series satellite application systems, and so on, and so forth. Moreover, in each case, every

system is systems engineering of huge groups of high technologies with strong integration characteristics and composed of microelectronics technologies with high degrees of integration, space technologies, computer technologies, remote sensing technologies, as well as such technologies as television, communications, navigation, and so on. However, speaking in terms of users, utilization is certainly not complicated. Moreover, developments are still in the directions of simplification and conversions toward convenience--for example, as far as communications satellite earth stations are concerned, in terms of technology, they have already realized unmanned operation. Utilization is extremely convenient.

II. BENEFITS ASSOCIATED WITH VARIOUS TYPES OF SATELLITE APPLICATION SYSTEMS AS WELL AS ROLES WITH REGARD TO VARIOUS TRADES AND PROFESSIONS

1. Satellite Television Application Systems

In today's society, television has already become an indispensable companion to culture and entertainment in the family lives of tens of thousands of people. Television has already, for the first time, made the aspiration of the ancients about the idea that "Scholars do not go outside the gate but know the affairs of the empire." into a reality in an even broader sense. Television is not subject to limitations associated with the highness or lowness of culture. It is capable in all cases of making viewers immediately comprehend the status of the locality, the whole nation, as well as various places in the world. It should be said that television makes people expand their field of view, develops intellect, popularizes education, and is the best means for improving qualities. However, before the popularization of satellite television, television transmission was only capable of being carried out in the cities or through microwave relay trunk line transmissions, again going through imperfect retransmissions. Limitations were very great. Moreover, image quality was difficult to guarantee.

Everyone knows that a decision consciousness exists. Whether or not one's field of vision is broad plays an important role in the improvement of people's quality. The farmer's in China's sea coast areas are capable of very quickly achieving prosperity relying on their own efforts. However, in marginal areas where the old and young are all poor, despite the fact that

the nation makes appropriations to lift up the poor year after year, improvements in life are still, however, very slow. Moreover, it is often this way. Outer suburbs are slower than inner suburbs. The farther one goes from cities, the slower the development is. It is desired to achieve, on a national scale, the popularization among eight hundred million farmers of television, the work of education by telecommunications, television by satellite alone, and satellite application systems associated with education by telecommunications. Only when this is done is it really possible to succeed.

In 1985, Premier Li Peng, with a high degree of strategic vision, personally took charge of example measures associated with the presenting as gifts of 53 satellite television receiver stations for poor outlying regions, vigorously switching on, and, in conjunction with that, setting off consciousness of and desire for satellite application industries in the various trades and professions. During the "75" period, more than 30 thousand satellite television receiver stations were installed domestically--an average of 6000 units each year. In 1985, just as the spread of satellite television receiver stations was beginning, the price of each unit was 60 thousand yuan - 100 thousand yuan. Now, however, it has fallen to around 10 thousand yuan. Besides this, in the skies over China, television programs sent through satellite transmitters have developed from a few to over ten. It is possible to foresee that, within the next 10 years, television programs transmitted through satellites in the skies over China will become even more numerous, even richer, and the numbers of satellite television reception stations installed will follow the market in expanding toward prefectures, towns, and even villages and families and will increase by numbers of fold or even tens of fold. If satellite television and education by satellite telecommunications is able to send out wisdom, culture, and education for remote farming villages associated with distant cities, mountain regions, sea islands, as well as remote areas, and, in conjunction with this, makes them broaden their outlook, improving their qualities, in that case, 800 million farmers will then be able to exact greater financial wealth from land which has not yet been fully exploited and utilized as well as many types of management. If China has half its farmers creating wealth like the farmers along the ocean--relying in that way on wisdom and contacts associated with the outside world--then, there will be no way to estimate the economic development which will be produced or increases in national power.

2. Satellite Communications Application Systems

Only fiber optic communications possess a development

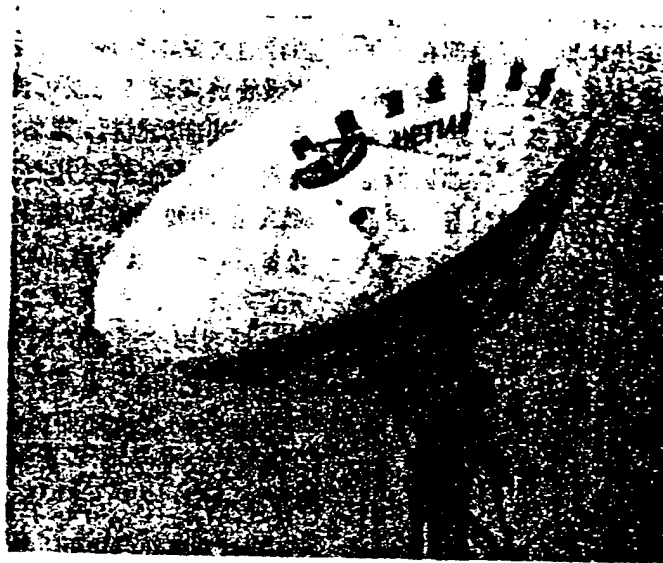
outlook which is capable of comparing to satellite communications. However, fiber optic communications are suitable for use over short distances as well as plain regions. Moreover, at the present time, the price is expensive. If one is then speaking in terms of the vast mountainous regions and outlying areas of the entire country, satellite communications possess more of their own unique advantages. As a result, as far as applications of satellite communications are concerned, people are already paying more and more attention to them. Comparing satellite communications with traditional open wire communications, coaxial cable communications, and microwave communications, they possess the clear advantages that follow. They are not subject to limitations associated with landforms. They can leap over high mountains, oceans, and deserts. Coverage areas are broad (They are not only capable of covering the whole country, but are able to cover the whole world). Communications quality is high. Reliability is high. Communications ranges are long. Flexibility and maneuver capabilities are good. Resource consumption is low. Maintenance and utilization are convenient. As a result, satellite communications have a vast developmental outlook.

Relevant international experts believe that communications--in particular, satellite communications--are a golden bridge for various nations toward prosperity, toward the world, and toward the future. In today's information age, satellite communications are necessarily linked together with economic prosperity. It is very difficult to imagine areas where information is not effective and there are no contacts with the outside world being capable of economic prosperity and moving out into the world. During the processes of reform and opening up, foreign merchants have already taken whether or not there is satellite communications equipment to be one of the prerequisites for whether or not to invest jointly. In "85" and "95" plans, China has already taken communications construction and the development of traffic and put them in a position of equal importance with energy resources construction. Satellite communications application operations associated with various departmental committees and various provinces and cities have already entered into early preparation stages of engineering implementation from the coordination and development phase. At the present time, our Beijing astronavigational satellite application group company already reaches close to 20 ministry committee level users associated with a synthesis of aviation and astronavigation ministry satellite applications. In all cases, they adapt to the requirements of modernized management in the planning for construction of specialized satellite communications networks. Moreover, various provinces and cities--in particular, mountain areas and remote provinces--are even more urgent with regard to the resolution of communications problems. For example, a certain mountain region province--when summarizing problems which existed during "65" and "75" periods--clearly pointed out that,

only with the resolution of mountain region communications and traffic problems is it then possible for their economies to rapidly prosper. Because of this, provincial governments decided to invest 2-5 hundred million yuan to use in construction of satellite communications networks. At the present time, Chinese companies also continue on with missions associated with the engineering of specialized satellite communications networks for close to one hundred stations as drawn up by the communications ministry.

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In the final analysis, how much money will it be necessary to spend for it to be possible for people to put forward and set up satellite communications networks or satellite communications earth stations? Also, what are the benefits? Can these be delineated? We now put forward a few example cases in order to explain.



Satellite Communications Station at Hetian in Xinjiang

(1) Bank Systems

At the present time, as far as bank systems are concerned, because of such factors as noncommunication of information, unclear situations, difficulties in control, and so on, it causes there to be, each day, over 50 billion yuan of funds being held up in basic level units or in transit. If these funds are able to be fully utilized, then, there will be interest of several billion yuan. Moreover, setting up a specialized satellite communications network of several hundred stations only requires 2-5 hundred million yuan. As a result, the benefits associated with the input to product ratios are very high. It also needs to be pointed out that this is first level benefit. If consideration is also given to the full utilization of this 50 billion yuan by various trades and professions, it will then bring with it even greater benefits.

(2) Communications Systems

Certain ministerial committees, in order to understand and, in conjunction with that, command and control scattered subordinate units at various places all over the country, lease every year 60 lines from the national microwave communications network. If calculations are done on the basis of the lease fee for each line each year being an average of 100 thousand yuan, then, every year, it is necessary to spend 6 million yuan. However, if set up is done of a satellite communications network having a total of 30 stations with 4 voice circuits for each station (figuring a total of 120 voice circuits), each station will cost approximately 6 hundred thousand yuan. The total of 30 stations will cost 18 million yuan. If one also adds in channel expenses, using 2-3 years of lease charges, it is then possible to buy a specialized satellite communications network belonging to the department in question as fixed assets. Moreover, specialized satellite communications networks constructed by themselves not only have high voice quality but can call and get through. In terms of function--besides voice communications--they also possess such functions as teleprinter, data, conference call, image facsimile, and so on. Important users also possess capabilities associated with forced diversion and forced cut ins.

(3) Satellite Metrological Application Systems

Since the precedent of the April 1, 1960 launch of the first successful U.S. metrological satellite, it has already been 31

years since the opening up of mankind's space soundings of the physical parameters associated with the earth's atmosphere. As far as metrological satellite sounding technology is concerned, it has already been successfully applied in a good number of realms associated with metrology, climate, agriculture, as well as earth systems sciences (atmosphere, oceans, land)--displaying great vitality. At the present time, satellite cloud image material has already become one important tool associated with weather forecasting activities. It plays a decisive role during final decision making associated with forecasts of certain disasterous types of weather. The economic benefits are extremely obvious. For example, in 1981, with respect to large Yangtze River water discharges, it was difficult for Central to determine for a time whether or not to divert the flood with the Jing River. Through materials acquired from metrological satellites, weather departments supplied accurate weather forecasts in a timely manner, causing Central to decide not to make the Jing River divert the flood. Because the flood was not diverted, a total of 100 million yuan in moving expenses was saved, avoiding the removal of 400 thousand people and the submerging of 600 thousand mu (0.0667 hectare) of good fields.

As another example, in 1987, from 6 May to 2 June, a great, seldom seen forest fire broke out in the Daxingan range of Heilongjiang. It was metrological satellite materials where it was first discovered, and, in conjunction with this, the status of the fire was accurately shown--providing accurate and reliable trends in the state of the fire in order to command the battle to extinguish it. Besides this, after applications were made of metrological satellite data to carry out weather forecasting, there were almost no missed forecasts of such things as the occurrence, development, and time of penetration into China for typhoons and storms. This has an inestimable role with regard to guaranteeing the safety of lives and property associated with fishing boats and oceangoing vessels along coastal areas.

Besides this, metrological satellite materials have, in all cases, extremely important roles with regard to such things as oceanic fishing, the growth of agricultural crops, sales, processing, as well as estimates of production, and so on.

For example, China supplies sea water temperature distribution diagrams on the basis of satellite metrology materials to certain fishing vessels, quickly finding large schools of fish which like to gather in the vicinity of warm fronts. One net can then catch over 200 tons. On the basis of reports, after the U.S. makes use of satellite metrological materials, it is possible each year to reduce disaster losses by 2 billion U.S. dollars. This is ten times the investment in metrological satellites.

(4) Satellite Resource and Geodetic Remote Sensing Application Systems

With the appearance of satellite geodetic application systems as well as satellite resource application systems--in respect to geodetic measurements and underground and underwater resource soundings--there has been almost a revolution in terms of technological means.

Geodetic remote sensing satellites take photographs of the surface from space or sense various types of remote sensing information. Not only is the coverage range broad, but they are capable of presenting characteristics of the earth's surface as well as geological structures, acquiring a good number of geographical characteristics and subterranean structures which are difficult to discover opting for the use of surface and aerial map making means. Moreover, speeds are fast, and expenses are low. For example, compiling a map of all of China at a scale of 1: 1,000,000 required in the past the taking of 1.5 million photographs. Large numbers of personnel were required to work for a period of 3-5 years. Now, only 600 satellite photographs are necessary. Only 6 operating personnel work for 5 months, and it is possible to complete it. Expenses do not come to 2% of the original ones. As far as the operational capacity of the Soviet Union's Salute Gun No.7 space station taking photographs for 5 minutes is concerned, if aircraft were used to take them, they would require two years, and only then would it be possible to complete them. Moreover, making maps with on site geological teams would require spending a period of 80 years. Besides that, with regard to satellite remote sensing, in such areas as degrees of accuracy, amounts of information for various types of uses, and so on, there is also no way to compare it with other means of measurement.

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On the basis of investigations of economic benefits associated with the first U.S. resources satellite, the following conclusions were reached. Including the launching of an earth resources satellite and the equipment connecting it to the surface, the average expenses each year are 20-50 million U.S. dollars. However, it has 43 different types of applications in such areas as geology, agriculture, forestry, water conservancy, and so on. Each year, it is possible to directly obtain more than 1.4 billion U.S. dollars in economic benefits. The ratios of profit to investment are 30-70 fold.

Since the construction of the northern section of China's Paochi Chengtu railroad in 1956, discoveries of damage have reached over 135. Travel interruptions total 4608 hours. This does not include operating losses. Dealing with only one item, outlays reach 72.4 billion People's yuan. The causes creating

the losses have never been clear. Later, making use of satellite photographs to carry out analysis, it was discovered that the area in question is spread out over three fracture belts running close to east-west. As a result, this seemingly stable piece of rocky ground was, in reality, an unusually fragile, fragmented piece of earth, thus finding out the real reason for the frequent railroad damage. As another example, as far as the "65" period is concerned, it was determined to build a large model thermal electric generating plant at a site selected in China's northeast. Luckily, before construction, satellite photography was used to carry out careful visual checks. It was discovered that the electric generating plant construction was on a fracture belt, thus avoiding the loss of investments valued at several hundred million yuan.

In the middle 1970's, petroleum departments discovered oil fields in regions on the edges of the Talimu (phonetic) basin. However, it was not known how large the region containing oil was. Later, they discovered from satellite photographs the scope of the area containing oil--that is, desert regions on photographs displaying a ring shaped flow associated with circles interlinked with each other. At this time, in a situation where there was no way for people or aircraft to enter into the desert hinterland to carry out surveys, it was discovered from satellite photographs that, as far as the scope of oil and gas was concerned, it should be said that it was an amazing find. If the scope of the oil and gas had been obtained through seismic prospecting, it would then have cost an investment of several hundred million yuan to even a billion yuan or more.

On the basis of statistics from China's Ministry of Communications, the country as a whole has 47.9% of its long haul trucks that are in a configuration of driving empty when they come back. As a result, the losses created in one year reach 6 billion yuan. The waste of gasoline and diesel fuel reaches 1.2 million tons. The causes creating this driving empty come primarily from a lack of information exchange between departments, between regions, and between vehicle owners and cargo owners. If use is made of RDSS systems to carry out rational dispatching and pull the strings as go between, it is possible every year to take in an additional 2.5 billion yuan. Moreover, using this sum of money, it is possible to set up RDSS systems with user capacities as high as tens of millions.

Also, China's railroad transport load is very heavy. Among these, the main line transport missions such as Beijing-Shanghai, Beijing-Guangzhou, Beijing-Harbin, and so on, are particularly onerous. However, with a view toward considering safety, when a second train sets out, it is necessary to get feedback information that the first train has passed through the first station in order to avoid the occurrence of accidents due to unanticipated situations between the two stations. However, the

interval between the two stations is approximately 8-10 minutes travel time domestically. If there is an RDSS system installed on each train engine, then, travel intervals can be shortened to 3 minutes. That is also nothing else than to say that one railway line can turn into two railway lines. Multiple tracks then become four. Speaking in terms of the Beijing-Shanghai line, the economic benefit each year is capable of increasing income 10 billion yuan. The even more important significance lies in slowly resolving difficulties associated with transport shortages. Besides this, RDSS systems will also play important roles with regard to reducing the occurrence of accidents associated with maritime, aerial, and land transportation means. The economic and social benefits are also very considerable.

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(6) Military Satellite Series

Relevant international experts believe that the applications of satellites in military terms has already become a mainstay of today's national defense construction. It is the "nerve center" of national defense systems. It is also the fourth battlefield following sea, land, and air to open up a struggle for air supremacy in the space frontier.

During the Middle East war which occurred last year, why was the U.S. Patriot missile capable of hitting Fleet Footed Runner (SCUD) missiles with high degrees of accuracy? Among the secrets was the U.S. aiming over 30 satellites at the Middle East battlefield. Patriot missile launch systems were notified in a timely manner through satellite systems of such things as where SCUD missiles were deployed, when they were launched, what trajectory, what frequency, and so on. Only then was it possible to hit SCUD missiles in a timely and accurate way. It should be said that satellite systems in the wars of the future really play the roles of "long range ears" and "long distance eyes" and are indispensable body guards in the domain of space.

The head of the national science commission, Comrade Song Jian, has pointed out that increases in material wealth during the "65" and "75" periods were primarily quantitative increases. However, during the "85" and "95" periods, that is, the 1990's, increases in material wealth must convert to the qualitative, that is, high scientific and technological development in order to realize them.

It should be said that various types of satellite application systems are all important members in the fields of high science and technology and cannot be ignored. Moreover, the development and application of high science and technology is not

only capable of achieving huge economic benefits. What is even more important is that, in the intense competition of international society, it is only when China possesses high science and technology that it is then possible for it to be stable, strong, and prosperous. Only then can the Chinese people be capable of becoming a force which cannot be ignored, standing like a giant in the grove of the peoples of the world. It is possible to foresee that, when satellite application technologies are popularized in their applications to the various trades and professions, it will necessarily be the day when China's pace of modernization construction speeds up!

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ASTRONAVIGATIONAL REMOTE SENSING TECHNOLOGY USED IN
TALIMU (PHONETIC) BASIN OIL AND GAS EXPLORATION

Petroleum Remote Sensing Research Institute

Ding Shubo

Translation of "Hang Tian Yao Gan Ji Shu Yong Yu Ta Li Mu Pen Di
De You Qi Kan Tan"; Aerospace China, No.1, Jan 1992, p 11

China's Talimu (phonetic) basin is a Mesozoic-Cenozoic inland basin. Its area is 560 thousand square kilometers. Oil and gas resources are abundant. Astronavigational remote sensing technology, which has developed rapidly, is not only capable of directly measuring the boundary form characteristics associated with Mesozoic-Cenozoic sedimentary basins. It is, moreover, capable of indirectly reflecting the internal structures of large scale sedimentary basins as well as achieving explanations with regard to structures and fractures. In the last few years, we have made use of astronavigational remote sensing technology in order to carry out oil and gas exploration with regard to the basin in question. Clear results have been achieved.

We make use of advanced digital imagery to handle mosaic technology. Color hues are blended and geometrical corrections are carried out with regard to 57 LANDSAT views covering the Talimu (phonetic) basin--forming an imagery mosaic reflecting the features of the entire basin. For many years, the area of the basin has been large, and operating conditions difficult. Besides the north Talimu (phonetic) area, the level of oil field exploration in the whole basin is very low.

At the present time, we primarily develop our research work from the several areas that follow.

1. Make use of satellite remote sensing information to carry out basin region geological research.

Beginning from studies of the lithological characteristics of strata that emerge at the periphery of the basin, large scale faulting interpretations are combined to make clear the patterns of formation, development, and evolution associated with the basin.

2. Make use of linear and ring characteristics on satellite remote sensing imagery to carry out tectonic research within the basin.

Linear structures and ring shaped structures which are reflected on satellite remote sensing imagery usually control sedimentation associated with different geological eras in the basin as well as the birth and development of structures, and the formation, movement, and collection of oil and gas.

3. Make use of astronavigational and aviation remote sensing data combined with surface chemical and physical surveys as well as surface wave harmonics to directly find stores of oil and gas.

At the same time, due to rapid improvements associated with wave spectrum resolutions for astronavigational and aviation sensors as well as digital imagery processing techniques, we have already begun to find surface indications of oil and gas stores in the north Talimu (phonetic) region. The theoretical basis of this type of method is nothing else than hydrocarbon type materials in stores of oil and gas migrating vertically to the surface in theoretical micro seep mechanisms. That is, underground hydrocarbons shifting vertically to the surface will produce alterations in surface vegetation, soil, rocks, and water bodies, thereby causing reflected wave spectra associated with land forms to give rise to changes. These are called surface paragenetic effects. This type of intergrowth effect causes abnormalities in remote sensing imagery hues and shadow pattern structures to combine with already known oil field remote sensing characteristics. Going a step further, it is possible to predict oil and gas collection belts associated with regions which are not yet known. This type of method has already been verified by the drilling of wells in a number of unusual regions and seeing industrial oil flows. For example, certain light colored unusual regions predicted by us in the area from Lunnan to Chehetang as well as the two bank regions on the north and south of the Talimu (phonetic) river may all be areas with good long range prospects for containing oil and gas. They are just awaiting verification by drilling wells.

A NEW ERA IN SATELLITE NAVIGATION AND POSITIONING SYSTEMS

--THE GEOSTAR SYSTEM

Pang Zhihao

Translation of "Xin Yi Dai Dao Hang Ding Wei Wei Xing Xi Tong--Ji Ao Xing Xi Tong"; Aerospace China, No.1, Jan 1992, pp 20-23

ABSTRACT The satellite radio positioning service (RDSS) is a new type of satellite navigation positioning technology which was introduced to the world in the middle 1980's. The U.S. Geostar system is a comparatively mature RDSS system which is being developed at the present time. This article introduces Geostar system composition, operating processes, and application ranges. In conjunction with this, comparisons are carried out between it and global positioning systems (GPS).

KEY WORDS Spacecraft Satellite communications U.S.

I. GENERAL SURVEY OF THE DEVELOPMENT OF NAVIGATION AND POSITIONING SATELLITE SYSTEMS

The U.S. first generation navigation and positioning satellite system--the TRANSIT system--was put into service in 1964. There are 100 thousand receiver units for this system in use in the world. The price of receivers has currently already fallen to 1500 U.S. dollars/unit. Making use of this type of system, it will only be possible to position once every 2 hours. As a result, people have gradually lost interest in it. The TRANSIT system project will terminate service in the middle 1990's.

Global positioning satellite systems (GPS) are second generation navigation and positioning satellite systems. There is an overall total of 18 satellites (space portion). This system requires the launching of satellites up to 1992. Only then will it be capable of complete operation full time. As far as satellite precisions are concerned, with regard to classified military code (P code), it is 10 meters. Code for civilian use (C/A code) is 100 meters. It is capable of providing 7 dimensional information (3 dimensional locations, 3 dimensional velocities, and precise time information). The receiver price was initially 15 thousand U.S. dollars/unit. Entering into the 1990's, it has already dropped to one thousand U.S. dollars/unit.

Although GPS is not yet fully operational, there was, however, another type of new satellite navigation and positioning technology introduced to the world in the 1980's. It is nothing else than satellite radio positioning services (RDSS--Radio Determination Satellite Service). Its functions include navigation (objects acquire location information for themselves), positioning (other users acquire object location information), and the carrying out of mobile communications (capable of being used in communications associated with moving objects and outlying farm village regions).

The most important characteristic of RDSS is the possessing of simultaneous navigation and communication capabilities. This point is extremely necessary in actual applications.

At the present time, RDSS systems, for which development is comparatively mature, are the U.S. Geostar systems. Completion time for this quasi global system is roughly the middle 1990's.

II. GEOSTAR SYSTEM COMPOSITION

The Geostar system is a type of radio positioning system. It is capable of supplying location information (longitude, latitude, altitude, and so on), radio navigation, and communications services between receivers. Transceivers are capable of being mounted on aircraft and moving vehicles on land, or being installed at certain fixed points on the earth, or being portable. Portable type transceivers are equipped with digital keyboards and liquid crystal displays.

Geostar systems are composed of space parts, surface central station parts, and user parts (transceivers).

The space portions of U.S. Geostar systems after they are fully complete include three satellites respectively positioned in geosynchronous orbits at 70°, 100°, and 130° west longitude. Besides these, there is also a satellite to act as an orbiting spare in order to satisfy the requirements associated with added new services or to replace satellites which give rise to malfunctions and power attenuation. Up and down links between satellites and user transceivers will respectively use 2483.5 - 2500MHz and 1610 - 1626.5MHz frequency bands. Up and down links associated with central ground stations will respectively make use of 6525 - 6541.5MHz and 5117 - 5183MHz frequency bands.

Central earth station parts include tracking and command equipment. In actuality, this is a complicated computer network including surface parabolic antennas corresponding to reception of each satellites signals. Computers are used in calculating user locations.

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Central surface stations operate in this way. During time period to, central surface stations use a carrier frequency of 6533.25MHz to sent a continuous series of query signals to Geostar satellite No.2 at 100° west longitude. The query signals in question are a series of special digital pulses. Query signals at 2491.75MHz make use of left handed circular polarized waves to transmit to users. Users send out each signal, and they will all go through Geostar's 1, 2, and 3, using 3 different time periods to return to the central surface station. The times t1, t2, and t3 at which signals reach central surface stations are computed from the original query signal transmission time to. The magnitudes are determined by the distances between users and various satellites. The sequence of returning signals sent from different users and reaching the central surface station is mixed up. It is necessary to make use of a distinguishing code among the various returning signals, differentiating them. The central computers of central surface stations store all the necessary identifying information. It is possible to take each returning signal and connect it to the specific user. Identifying information associated with each returning signal for different users is decoded when it arrives. Central surface station computers are then able to get and differentiate a set of accurate return signal arrival times for each user, thereby

calculating time period differences as well as solving for 3 unknowns in 3 equations (the 3 location coordinates of users relative to the surface). After that, as far as central surface stations are concerned, encryption is carried out with regard to these 3 pieces of information. Following that, they are transmitted back to the relevant specific users. Encrypted radio determination signals are sent to users on linear vertically polarized waves at a frequency of 6933.25MHz. The address encryption within radio determination signals must be compared to the specialized address of the designated user in question. If the address matches, then, the radio determination signal in question will be decoded on the users digital display equipment, and, in conjunction with this, show up.

User sections are nothing else than high capacity transceivers. Specific operational processes are as follows. After central surface stations send out query signals which go through frequency expansion modulation (the signals in question are divided into several frame signals)--starting out from their own individual requirements--each user's transceiver is made to react to specially designated time frame signals. In accordance with stipulated frame signals, user transceivers send out their recognition codes and information that needs to be sent (the information in question carries with it specially designated coding to identify the user in question). The signals which each user sends out are received by Geostar 1, 2, and 3. After that, they are transmitted to the central surface station.

Besides this, in order to use difference methods to correct system errors associated with determined user locations--within areas where users are distributed--there exist beforehand a series of datum stations which are positioned precisely. They are basically similar to user equipment. Each station is set up at intervals of 200-300km, presenting a grid distribution.

III. GEOSTAR SYSTEM OPERATING PROCESSES

In general situations, Geostar central ground station high speed computers transmit query signals through satellites multiple times each second. Moreover, user transceivers on the surface (including aircraft and ships) are set in configurations where they only receive and do not send information. When mobile users want to acquire the location data or need to understand current time information as well as central computer systems giving rise to alarm calls, user transceivers then transmit a short pulse group. This type of pulse group includes unique transceiver identification codes, information users hope to send, as well as correction codes. Transmission processes are roughly that signals go through at least two satellites and are relayed to the computer systems of central surface stations. After computer systems analyze the numbers of these signals that arrive, user location data are produced. Next, the user location data which have finished calculations are sent to user transceivers. Computers are also capable of storing location information in order to facilitate calculating speeds. Perhaps for the sake of requirements associated with monitoring the status of fleets of warships as well as other radio positioning services, computers are also capable of taking relevant information and relaying it to user general headquarters.

Geostar systems are capable of supplying radio positioning with accuracies of 1-7 meters as well as radio navigation information. Planned services are appropriate for use with 4 basic user types: aircraft, warships, land vehicles, and single people on foot. In all cases, each user is capable of entering into the systems in question through such methods as position requests, emergency calls, or auxiliary communications and so on. On the basis of the requirements of individual users or group users, flexible central surface station computer software is capable of permitting system services to undergo some alterations. Through connections with central data bases or other digital communications networks, Geostar satellites are also capable of distributing and transmitting other forms of information related to positioning.

As far as Geostar systems are concerned--besides being primarily used in radio positioning services--they also possess auxiliary communications functions. Users are capable of taking short digital messages and sending them into transceivers. In conjunction with this, designated recipients send these messages through satellite relays. Under normal circumstances, this process should be complete within one second. If communications information is not capable of normal transmission, central surface computer systems then send commands to user transceivers

notifying them to transmit again.

User transceivers will have a factory set permanent specialized digital code. It is not necessary to go to memory. They are capable of identifying transmitted and received electrical messages. When there is a need for directional guidance or to send electrical messages, it is only necessary to push a button once. After several seconds, Geostar satellite directional guidance signals will then appear on transceiver display devices. In conjunction with this, they tell you if the electrical messages have already arrived safely at the central ground station. During the sending of electrical messages--when the recipient of electrical messages automatically gives you receipt for them--your transceiver will show signals a second time. The Geostar system, when performing these operations, has security characteristics which are absolutely safe and reliable.

Besides positioning, directional guidance, sending and receiving of electrical messages, as well as emergency contacts, Geostar systems also have capabilities to provide information. Vehicle borne or person portable types of transceivers are capable of providing you such things as aviation company regularly scheduled flight times, weather forecasts, financial conditions, and so on.

IV. COMPARISONS WITH GLOBAL POSITIONING SYSTEMS

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Geostar systems are a type of active, closed loop positioning and navigation system. The basic point associated with their design concept is to take all the technological difficulties and move them to central ground stations to be resolved. As a result, the satellite body equipment and user equipment associated with the systems in question will be much simpler than GPS. In conjunction with this, there are both positioning and communications functions, thereby enlarging service functions to users.

GPS systems are used primarily in the military. Only C/A code is released for civilian use. Moreover, precisions are low. Geostar systems, however, are primarily used in civilian applications. The positioning precisions are capable of reaching around 10 meters--equivalent to GPS P code positioning.

GPS system military use terminals are only capable of receiving signals--one way data transmissions. They are, moreover, not capable of transmitting up link signals to satellites. If this were not the case, it would then violate security requirements associated with "radio silence". In this way, positioning calculation operations are made to be carried out in user receivers, thus leading to terminal costs that are comparatively high. However, Geostar system position calculations are completed in a main surface center. After that, calculation results are taken and given to users by retransmission through satellites. As a result, user terminals are simple. Moreover, they are also capable of transmitting

signals to satellites. For active, two way data transmission, terminal costs are capable of being very low.

Geostar satellite systems belong to active reply type positioning systems. Therefore, concealment capabilities are poor. As far as this point is concerned, they are far inferior to opting for the use of the passive type positioning methods of GPS. However, it is possible to make use of sudden transmission characteristics associated with signals requesting positioning as well as appropriate false noise encoding techniques in order to compensate for inadequacies in this area.

GPS belongs to "open types". It is only necessary to install GPS receivers (understanding their operating frequencies) and it is then possible to make use of them. Geostar systems, by contrast, belong to "closed types". User transceivers must first send discrimination codes to tell central computers that users are appointed ones who have already been approved. Opting for the use of systems associated with reply type positioning methods, it is necessary that they be closed loop systems. The numbers of users have an upper limit. Otherwise, systems will be paralyzed because of oscillations. When designing this type of system--in signal transmission systems--it is necessary to opt for the use of a series of measures--for example, comprehensive option for the use of multiple channel, multiple address technologies such as frequency separation, time separation, code separation, space separation, and so on, as well as multichannel random receiver technologies, and so forth, to make systems capable of accomodating random users reaching several hundreds of thousands to several millions. In all cases, the technological difficulties are resolved in central surface stations, thereby guaranteeing simple and cheap satellite and user equipment. Functions of this type are many (guidance, positioning, communications). Terminals are inexpensive. Moreover, central stations have advantages associated with operating control over functions and a sovereign position as well as being capable of carrying out statistical analysis of income and expenses--very greatly facilitating commercial applications.

Compared to the GPS system composed of 18 satellites, Geostar only requires 2-3 satellites and it is then possible to set up a system. However, this type of system is only capable of actualizing positioning and navigation of a regional nature. If it is desired to realize global positioning, it is necessary to take multiple regional systems and carry out net connections. In principle, global netting requires 6 geostationary orbit satellites and 3 central ground stations. Their technical parameters and signal formats must be unified. Central stations possess repeater transfer functions. At the same time, the time period required for one iteration of positioning will increase to several seconds.

In military applications, Geostar systems have definite limitations. These are primarily reflected in such areas as regional coverage, bad central station counter destruction capabilities, active positioning creating poor concealment

characteristics, and so on. However, in system signal design, option is made for the use of corresponding remedial measures. For example, option is made for the use of such measures as pseudo random code frequency expansion modulation, signal compression, reserve central stations, and so on. On the other hand, Geostar system communication functions are also capable of supplying links for military command systems--displaying the superiorities of systems where one satellite has multiple utilizations. Despite the fact that this is the case--as military positioning systems--the performance of Geostar systems in this area is still not as good as GPS.

V. GEOSTAR SYSTEM APPLICATIONS

Due to the fact that Geostar systems possess such characteristics as speed and timeliness, flexibility and convenience, and low prices, they, therefore, possess far ranging prospects for application.

1. Applications in the Area of Aviation

(1) Communications, Navigation, and Surveillance (CNS)

CNS is the overall designation aviation experts use with regard to the next generation of avionics systems. Geostar systems belong to combined CNS systems. Through them, aircraft are capable of flexibly, conveniently, and cheaply acquiring navigation and positioning information. It is also possible to maintain two way communications capabilities with ground controllers. This type of two way digital communications will replace current VHF frequency band radio systems which do not have good results. Geostar system navigation information is capable, as needed, of independently supplying pilots.

(2) Applications in Collision Avoidance Systems (CAS)

CAS is primarily used in aircraft traffic dispatching errors or at times when there is the occurrence of unsafe incidents which cannot be foreseen associated with violations of aviation traffic arrangements.

Basic RDSS CAS is capable of making aircraft positions show up on central displays associated with 30-60 nautical mile aviation traffic management position diagrams for each aircraft carrying it. The position diagrams carried are capable of displays of such activities services as airfield runways, navigation assistance, positioning, aviation traffic glide slope control, as well as all planned movements of short range aircraft. RDSS will be the principal signal source associated with aviation traffic management CNS. Making use of it, it is possible to carry out frequent checks with regard to conflict situations associated with aviation traffic. In conjunction with this, precise determinations are made of control measures which need to be opted for.

On the basis of inference, making use of RDSS, it is finally possible to set up completely independent aircraft flight and aviation traffic control systems. For example, transmitted signals produced by transceivers are capable of triggering

aircraft ignition switches. Control centers are able to grasp the type of aircraft (on the basis of previously set up user registration data) as well as airfield positions (on the basis of RDSS range finding data). Through satellites, control centers are capable of pulling out from memory any airfield glide path or runway approach data needed. After that, contact is made with the airfield that passengers hope to land at, causing aircraft to safely fly toward the destination.

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(3) Selecting Channels for Emergency Locating Transmitters

Relevant laws and regulations require that, from now on, all aircraft must be fitted with emergency locating transmitters (ELT) in order to facilitate--when collisions occur--the possibility of independently making use of 121.5MHz frequencies to send out signals. Aircraft flying at high altitudes and special use satellite receivers then tune on this frequency, preparing, as needed, to receive distress signals. The set up of ELT systems will be a great help with regard to fast discovery of downed aircraft and rescuing survivors as quickly as possible. However, ELT systems have two basic problems. The first is that, going through checks, there are false alarms in over 98% of ELT transmissions. This is due to the fact that violent descents or other jolts trigger ELT. The result is to create an extremely large, useless waste of rescue personnel strength and materiel. The second is that, contrary to the former, severe collisions create ELT that do not transmit signals.

Through RDSS, these two problems are capable of being resolved. Making use of RDSS, control center computers are able to monitor aircraft positions within the entire flight times of aircraft. Computers can take flight paths and digital maps which are stored (including aerial navigation factors such as airfields, obstacles, and so on, and appropriate to level areas associated with descents) and carry out comparisons as needed. When computers check out aircraft deviations off airfields and paths for entering into ground areas where it is possible to go down, control centers then send out may day to aircraft (alarm signals associated with radio voice). If aircraft have already undergone collision, control centers will then immediately ascertain the precise position where the accident occurred.

2. Applications in Land Systems

Truck transportation often gives rise to driving empty. This creates huge direct economic losses for vehicle owners. The primary causes are information that does not get through between vehicle owners and cargo owners and thus their not being matched in loads. If use is made of Aerostar systems, it is then possible to effectively gather vehicle circulation information, carrying out dispatching and command in a timely manner, and then, matching them up with other administrative and economic management measures. It is then possible to very, very greatly reduce rates of driving empty.

In a number of countries, railroad transportation accounts for a majority of the amount of transportation traffic. However, for a long time, it has not been possible right along to satisfy

transportation requirements which are growing every day. As far as lengthening trains goes, there exist such problems as inadequate horse power in engines, station platforms being short, and so on. Investments to construct new railroads are too large. All of these are unable, in basic terms, to ameliorate shortage conditions in transportation. However, application of Aerostar systems to set up railroad satellite positioning as well as communications control systems is a good way out. The principal functions are as follows. Through Aerostar systems, control centers do real time determinations of train locations and speeds, causing travel intervals to shorten from the current 8-9 minutes to 3 minutes. In this way, transportation capabilities are able to increase one fold at a minimum. Besides that, this system is capable of making scheduled reports on engine technical statuses and cargo conditions, thus eliminating waste from empty runs and very, very greatly lowering railroad accident rates. Today, with the occurrence of train collision accidents one after the other, application of Aerostar systems has even more significance. The U.S. Burlington local railroad company used similar systems and demonstrated that safety and reliability can improve 100 fold.

Besides this, making use of Aerostar systems, it is also possible to carry out continuous surveillance of important freight supply processes. Through the systems in question, it is possible to catch any criminal interceptions or thievery in progress, automatically sending the alarm to the nearest law enforcement agency.

3. Maritime Applications

Due to the fact that Aerostar systems are continuous, real time guidance and positioning systems associated with multiple functions, high accuracy, and low price, and user transceivers are small and ingenious as well as simple, they will, therefore, be capable of wide spread use in maritime activities--for example, improved emergency positioning indication radio beacons (EPIRB), supplying vessel traffic activity positioning information and reports, vessel dispatching, identification of fish schooling areas, control of towing on rivers and waterways, monitoring and control of anchoring, monitoring and control of commercial fleets, investigations of earthquakes and hydrology, identification of the boundaries of river dredging, set up and replacement of aids to navigation (navigation buoys), monitoring used in auxilliary positioning for navigation, search and rescue project management, mishap positioning, maritime exploration, hoist positioning, as well as tracking oil spills, and so on.

4. Other Applications

Applying Aerostar systems, it is possible to acquire relative positioning information in order to carry out geodetic measurements. This is very useful with regard to mineral and petroleum departments. Aerostar is also capable of use in exploration activities, as well as in the measurement and reporting of floods, fires, and so forth.

VI. CONCLUSIONS

After the presentation in 1984 of the Aerostar design concept, it has already, at the present time, given rise to interest in departments in various nations of the world in association with applying it. Its outstanding advantages are high precision, small investment, simple and inexpensive user equipment, and multiple service functions. However, due to the fact that the system in question concentrates all technical difficulties in central stations for resolution, central station equipment is thereby caused to be enormous and complicated. Moreover, there are a good number of new technologies and new problems that await probing and resolution. Part of the equipment associated with the system in question has already had carried out on it tests loaded together on maritime satellites. It is estimated that it will be possible to introduce it to the world in the middle or late 1990's.

BAIKENUER (PHONETIC) FIRING RANGE WILL BECOME
COMMERCIAL COMPANY

He Xing

Translation of "Bai Ke Nu Er Fa She Chang Jiang Bian Wei Shang Ye Gong Si"; Aerospace China, No.1, Jan 1992, p 23

According to 12 November 1991 reports in "Astronavigation Daily", in order to compete with commercial launch enterprises, the Soviet Union's Baikenuer (phonetic) firing range will establish a partnership company. Hasake (phonetic) aviation research institute, the Russia and Ukraine aviation association, as well as commercial banks will hold 87% of the stock in this company. The rest of the stock will be sold to private investment firms.

The Soviet Union's energy resources financial group companies have put forward a request with regard to ownership of the Peace space station. In conjunction with this, the establishment of a central organization is appealed for in order to prevent the Soviet astronavigation industry from disintegrating.